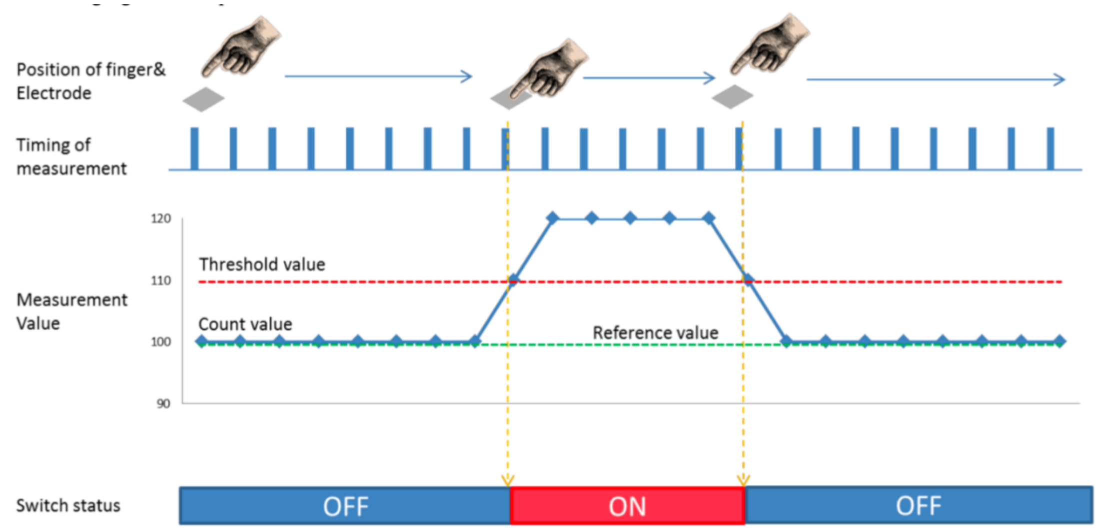
# Exhibit 7

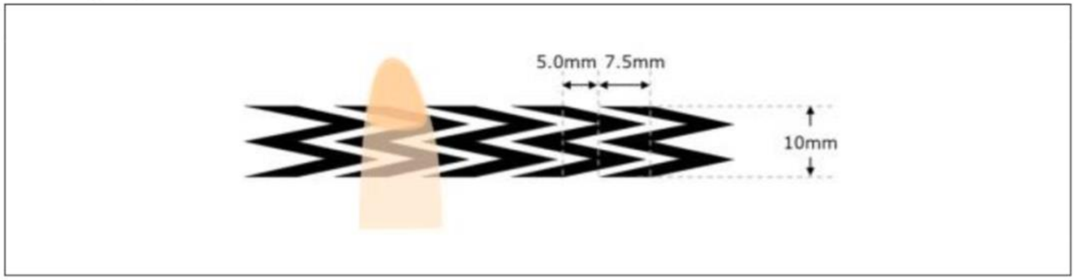
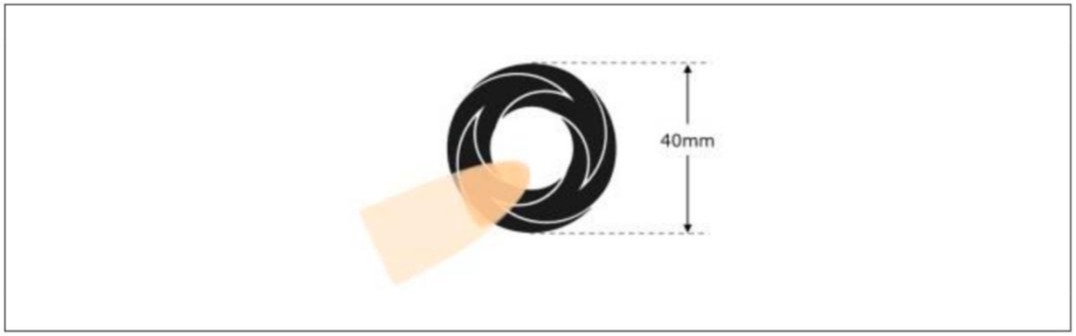
# U.S. Patent No. 8,432,173 ("'173 Patent")

**Exemplary Accused Products**

Renesas products, including at least each of the following products (and their variations) infringe at least Claim 1 of the '173 Patent: Renesas RX microcontrollers with capacitive touch, such as RX113, RX231, RX230, and RX130. The infringement chart below is based on the RX113 microcontroller ("RX113 MCU"), which is exemplary of the infringement of the '173 Patent.

| Claim | RX113 MCU |
|---|---|
| [1pre] A method comprising: | The RX113 MCU provides capacitive touch sensing functionality.<br><br>RENESAS Application note<br>RX113 Group<br>CTSU Basis of Cap touch detection<br>R30AN0218EJ0100<br>Rev 1.00<br>25th Dec 2014<br>Summary<br>RX113 group is incorporated a hardware (Capacitive Touch Sensor Unit; CTSU) that detects human body contact by measuring capacitance existed between touch electrode and human body.<br>This application note introduces the principle of capacitive touch detection as well as explains the detail of current-frequency conversion system that is used in RX113.<br><br>*See* https://www.renesas.com/en-us/doc/products/mpumcu/apn/rx/002/r30an0218ej0100_rx113.pdf at 4 |
| [1a] receiving one or more first signals indicating one or more first capacitive couplings of an object with a sensing element that comprises a sensing path that comprises a length, the first | The RX113 MCU receives one or more first signals indicating one or more first capacitive couplings of an object with a sensing element that comprises a sensing path that comprises a length, the first capacitive couplings corresponding to the object coming into proximity with the sensing element at a first position along the sensing path of the sensing element. |

| | |
|---|---|
| capacitive couplings corresponding to the object coming into proximity with the sensing element at a first position along the sensing path of the sensing element | For example, the RX113 MCU implements touch and movement functionality where the user places a finger/stylus on the connected touch sensor and moves it along a path or line. When the user's finger/stylus comes in contact with the touch sensor ("the object coming into proximity with the sensing element . . ."), one or capacitive couplings between the finger and the touch sensor is formed ("one or more capacitive couplings of an object with a sensing element . . ."). The RX113 MCU receives one or more first signals indicating that the user places a finger/stylus on the touch sensor ("receiving one or more first signals indicating one or more first capacitive couplings of an object with a sensing element . . .").   **Figure 2-9 ON/OFF switch judgment** *See* https://www.renesas.com/en-us/doc/products/mpumcu/apn/rx/002/r30an0218ej0100_rx113.pdf at 7 |

| | |
|---|---|
| | **3.1 Example of Slider Electrode Layout Pattern Design**<br>Figure 3-1 shows the recommended pattern for a slider electrode in the self-capacitance method. This pattern is designed for finger touch and ensures that 3 electrodes respond when the slider is touched anywhere other than the two ends.<br>To change the size of the slider, adjustments must be made by adding or removing electrodes rather than expanding or shrinking the pattern.<br><br><br>Figure 3-1 Recommended Pattern for Slider Electrode in Self-capacitance Method<br><br>**3.2 Example of Wheel Layout Pattern Design**<br>Figure 3-2 shows the recommended wheel electrode pattern for the self-capacitance method. This pattern is designed for finger touch and ensures that 3 electrodes respond no matter where the wheel is touched.<br>To change the size of the wheel, adjustments must be made by adding or removing electrodes rather than expanding or shrinking the pattern.<br><br><br>Figure 3-2 Recommended Wheel Electrode Pattern for Self-capacitance Method:<br><br>*See* https://www.renesas.com/en-us/doc/products/mpumcu/apn/rx/002/r01an3958ej0100-ctsu.pdf at 25 |

| | |
|---|---|
| | <br>*See* https://www.renesas.com/en-us/doc/products/mpumcu/doc/rx_family/r30ca0159ej0300-touchkey.pdf at 1 |

**Hygienic and less prone to malfunction**

Mechanical key assemblies have physical gaps that allow dust and water to get inside. In contrast, touch keypads have a flat surface that can easily be wiped clean with a cloth. Their excellent resistance to dust and moisture make them more durable than mechanical key assemblies, and they are less prone to malfunction when used as frequently operated controls.

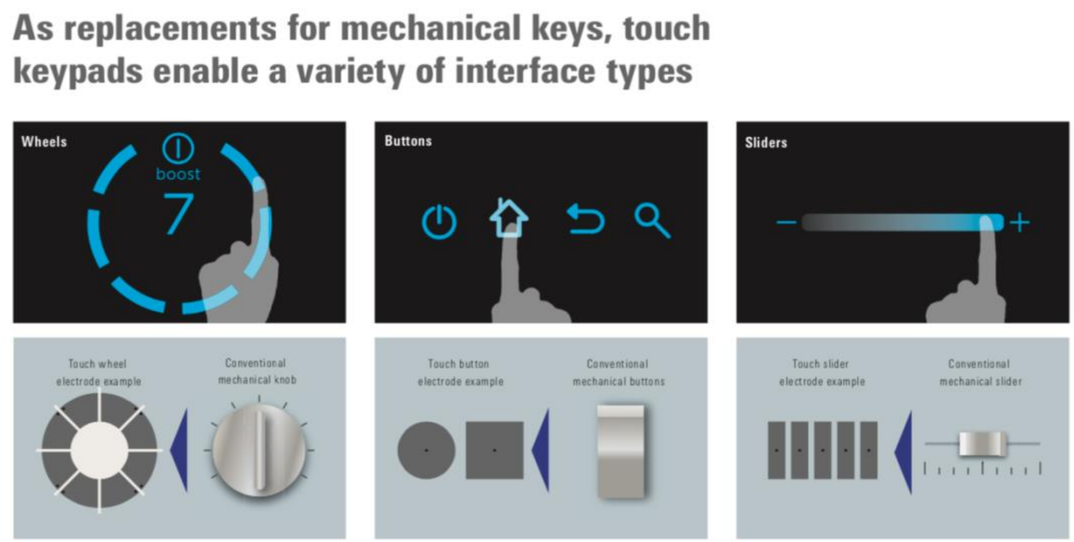

Flat panel with excellent resistance to dust and moisture

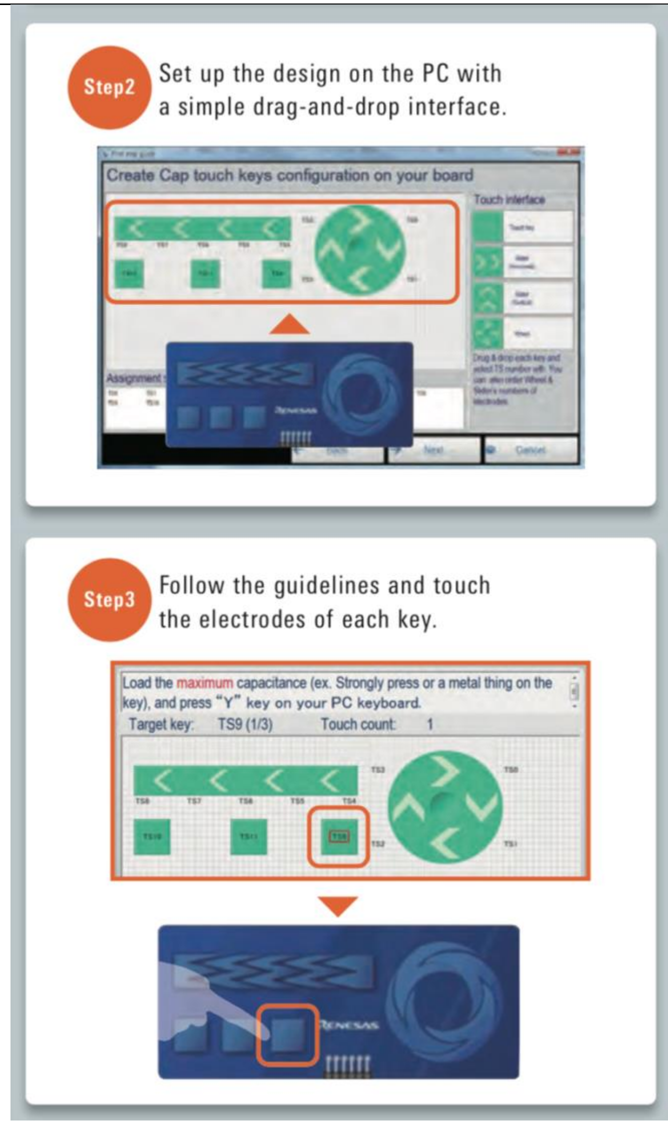
**Attractive design possibilities**

Touch keypads can be configured to blend in visually with the exterior casing of products, providing a great deal of design flexibility. No longer is it necessary when adding new functions to a product to provide complex and diverse mechanical controls such as wheels, buttons and sliders. Capacitive touch interfaces provide an excellent HMI with high added value by combining ease of operation and aesthetically appealing design.

Neat design integration of function keys of different types

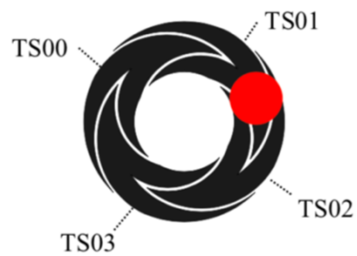
*See* https://www.renesas.com/en-us/doc/products/mpumcu/doc/rx_family/r30ca0159ej0300-touchkey.pdf at 3

| | |
|---|---|
| | <br><br>*See* https://www.renesas.com/en-us/doc/products/mpumcu/doc/rx_family/r30ca0159ej0300-touchkey.pdf at 3 |




*See* https://www.renesas.com/en-us/doc/products/mpumcu/doc/rx_family/r30ca0159ej0300-touchkey.pdf at 4

Example : When the touch point is Figure 6.2




Non touch measurement data average : 16000
g_wheel_data[]
[0](TS00) 16500
[1](TS01) 17500
[2](TS02) 17000
[3](TS03) 16000

**Figure 6.2 Touch point and measurement data**

The maximum channel becomes TS01 channel from Figure 6.2.

*See* https://www.renesas.com/en-us/doc/products/mpumcu/apn/rx/002/r30an0216ej0100_rx113.pdf at 61.

**Pattern 1**

maxch[]

[0] 1 --- Max measurement data channel number
[1] 0 --- Max measurement data channel number – 1
[2] 2 --- Max measurement data channel number + 1

**Pattern 2** Max measurement data channel = 0

maxch[]

[0] 0 --- Max measurement data channel number
[1] **3** --- Max measurement data channel number – 1
[2] 1 --- Max measurement data channel number + 1

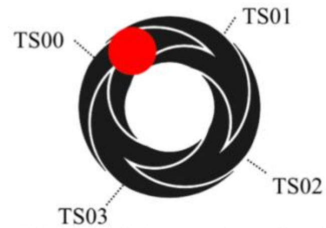



**Figure 6.4 Pattern2 touch point**

**Pattern 3** Max measurement data channel = 3

maxch[]

[0] 3 --- Max measurement data channel number
[1] 2 --- Max measurement data channel number – 1
[2] **0** --- Max measurement data channel number + 1

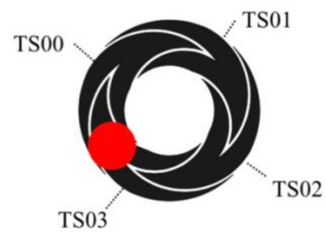
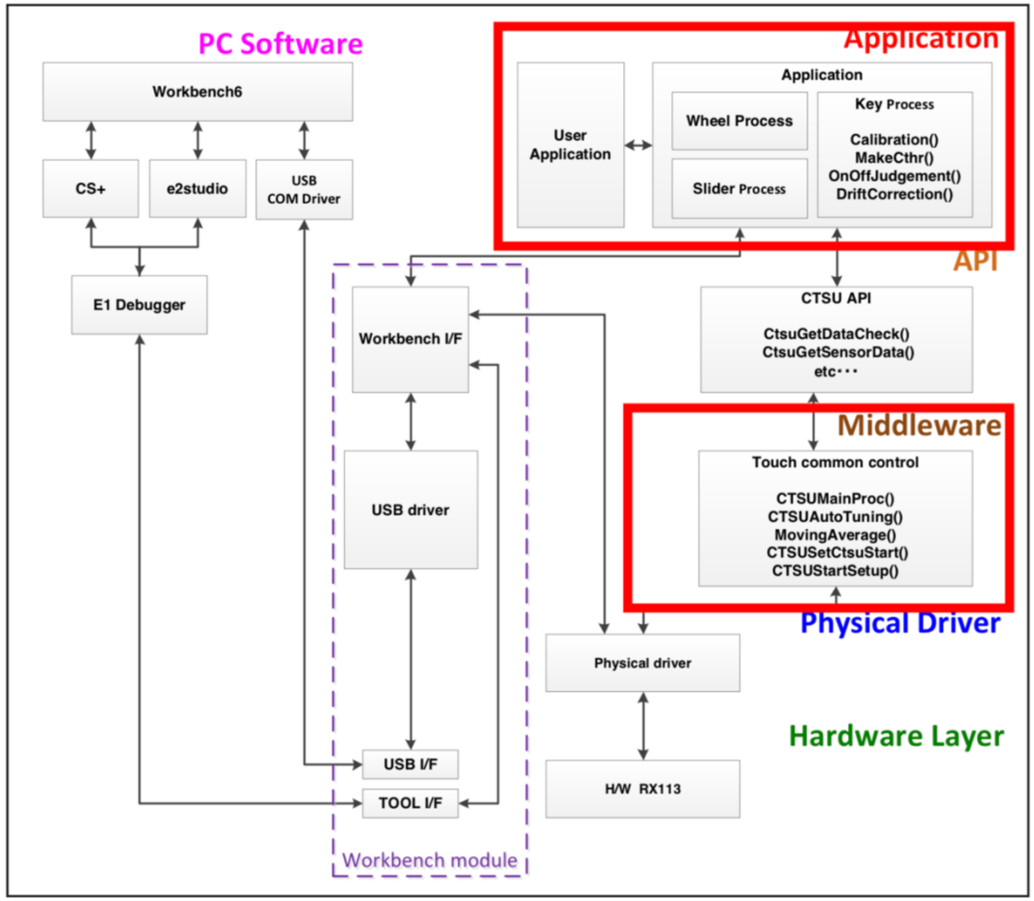
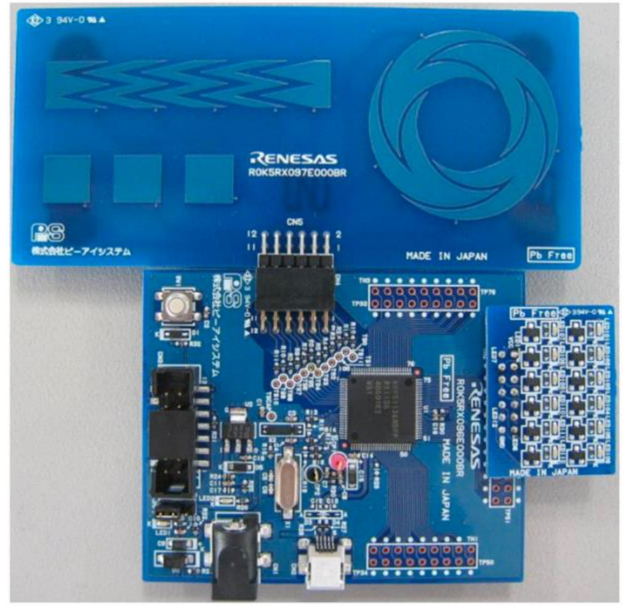



**Figure 6.5 Pattern3 touch point**

*See* https://www.renesas.com/en-us/doc/products/mpumcu/apn/rx/002/r30an0216ej0100_rx113.pdf at 62.

| | |
|---|---|
| | 4.1 Operation Overview<br>Figure 4.1 shows a system block diagram.<br><br>**Figure 4.1 System Block Diagram**<br>*See* https://www.renesas.com/en-us/doc/products/mpumcu/apn/rx/002/r30an0216ej0100_rx113.pdf at 6. |

<table>
<tr>
<td></td>
<td>
3.1 Hardware Configuration<br>
Figure 3.1 shows an substrate configuration<br>

<br>
**Figure 3.1 Substrate configuration**<br><br>
*See* https://www.renesas.com/en-us/doc/products/mpumcu/apn/rx/002/r30an0216ej0100_rx113.pdf at 5.
</td>
</tr>
<tr>
<td>[1b] determining based on one or more of the first signals the first position of the object along the sensing path;</td>
<td>The RX113 MCU determines based on one or more of the first signals the first position of the object along the sensing path. *See, e.g.*, analysis and evidence in claim element 1[a] above.<br><br>For example, at the beginning of a movement, the user’s finger/stylus (“object”) touches the touch sensor. The RX113 MCU receives one or more first signals and determines the location where the user’s finger/stylus touched the touch sensor (“the first position of the object along the sensing path”).</td>
</tr>
</table>

| | |
|---|---|
| | For example, the RX113 MCU has functionality that track touch and movement, including receiving information about the location, size, and movement of a touch occurring on the screen. This also includes information for the view or window in which the touch occurred, the location of the touch within the view or window, and the approximate radius of the touch. This also includes information about indicating when the touch occurred, and information about whether the touch began, moved, or ended. |

35.3.2.4 Self-Capacitance Multi-Scan Mode Operation

In self-capacitance multi-scan mode, electrostatic capacitance on all channels that are specified as measurement targets by setting the CTSUCHAC0 and CTSUCHAC1 registers are measured sequentially in ascending order. Figure 35.14 shows the software flowchart and an operation example, and Figure 35.15 shows the timing chart.

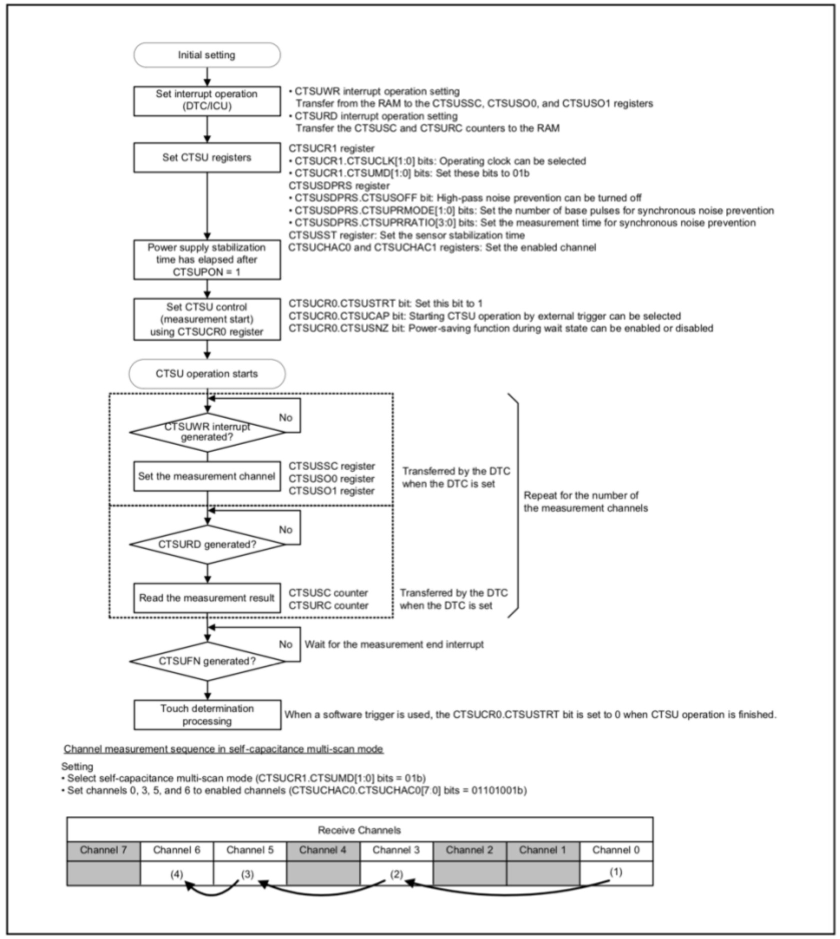
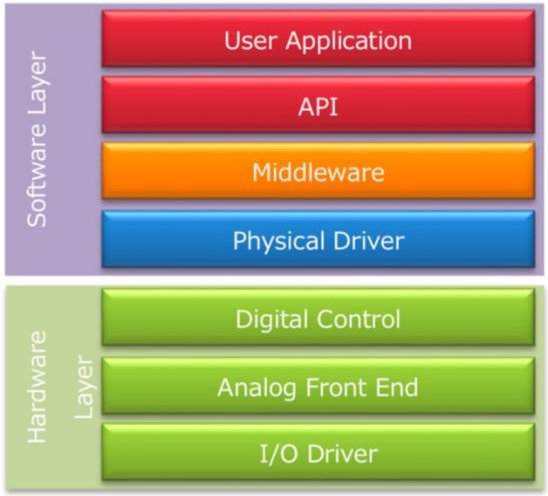
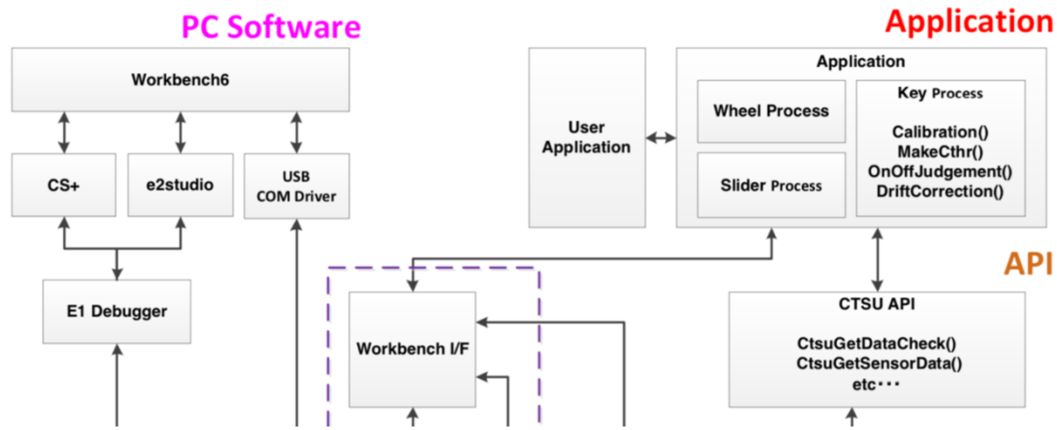


**Figure 35.14 Software Flow and Operation Example of Self-Capacitance Multi-Scan Mode**

*See* https://www.renesas.com/en-us/doc/products/mpumcu/doc/rx_family/r01uh0448ej0110_rx113.pdf at 1221.

| | |
|---|---|
| | 3.1 Overview<br><br>Overview of Renesas's capacitive touch detection system is shown in figure 3-1. The system is divided into a hardware part and a software part. The Hardware part includes I/O Driver part that connects directly to touch electrode and convert the capacity to electric current in pulse drive, Analog Front End part that converts the electric current to frequency, and Digital Control part that passes capacity measurement value to software by controlling these blocks. The Software part includes Device Driver that controls hardware, Middleware API that performs position determination of finger by slider, wheel, and matrix electrode, and Middleware API and user application that performs I/F with upper application.<br><br><br><br>Figure 3-1 Renesas's capacitive touch system<br><br>*See* https://www.renesas.com/en-us/doc/products/mpumcu/apn/rx/002/r30an0218ej0100_rx113.pdf at 8 |

| | |
|---|---|
| | 3.3 Firmware<br>3.3.1 Overview<br>General View of Software is shown in figure 4-10. Software consists of Physical Driver, Middleware, API, and Application. Physical Driver exchanges data directory with CTSU and exchange the data with upper layer. Middleware process the ICO value obtained via Physical Driver and pass it to API. It also has a role to pass the command which is specified by the upper layer to Physical Driver. API mediates the exchange of data between Application layer and Middleware layer. Application is the entity of touch key, slider, and wheel processing. It returns ON/OFF status of the key and the finger position on the slider and wheel depending on the request of User Application. Also, it includes the debugger interface to connect with the capacitive touch integrated development environment "Workbench6" and USB interface.<br><br><br>*See* https://www.renesas.com/en-us/doc/products/mpumcu/apn/rx/002/r30an0218ej0100_rx113.pdf at 14<br><br>3.3.5 Application<br>Application is an entity of touch key, slider, and wheel processing. It performs the following processing from data that was collected by API.<br>-Calibration processing<br>-Follow-up correction processing of measurement data to environmental changes<br>-ON/OFF processing of the key<br>-Detection processing of slider and wheel position<br>-User's applications such as system control of the product and display of LED and LCD. |

| | |
|---|---|
| | *See* https://www.renesas.com/en-us/doc/products/mpumcu/apn/rx/002/r30an0218ej0100_rx113.pdf at 15 |
| [1c] setting a parameter to an initial value based on the first position of the object along the sensing path, the initial value comprising a particular parameter value and being associated with a range of parameter values, the range of parameter values being associated with the length of the sensing path; | The RX113 MCU sets a parameter to an initial value based on the first position of the object along the sensing path, the initial value comprising a particular parameter value and being associated with a range of parameter values, the range of parameter values being associated with the length of the sensing path.<br><br>The RX113 MCU sets a parameter to an initial value based on the first position of the object along the sensing path.<br><br>In the RX113 MCU, the initial value comprises a particular parameter value and being associated with a range of parameter values, the range of parameter values being associated with the length of the sensing path.<br><br>For example, the initial value comprises a particular parameter value or setting that can be adjusted, and is associated with a range of parameter values, e.g., the range of adjustment. Further, the range of parameter values or settings is associated with the length of a sensing path and can be adjusted along the length of that path. |

### 35.3.2.4 Self-Capacitance Multi-Scan Mode Operation

In self-capacitance multi-scan mode, electrostatic capacitance on all channels that are specified as measurement targets by setting the CTSUCHAC0 and CTSUCHAC1 registers are measured sequentially in ascending order. Figure 35.14 shows the software flowchart and an operation example, and Figure 35.15 shows the timing chart.

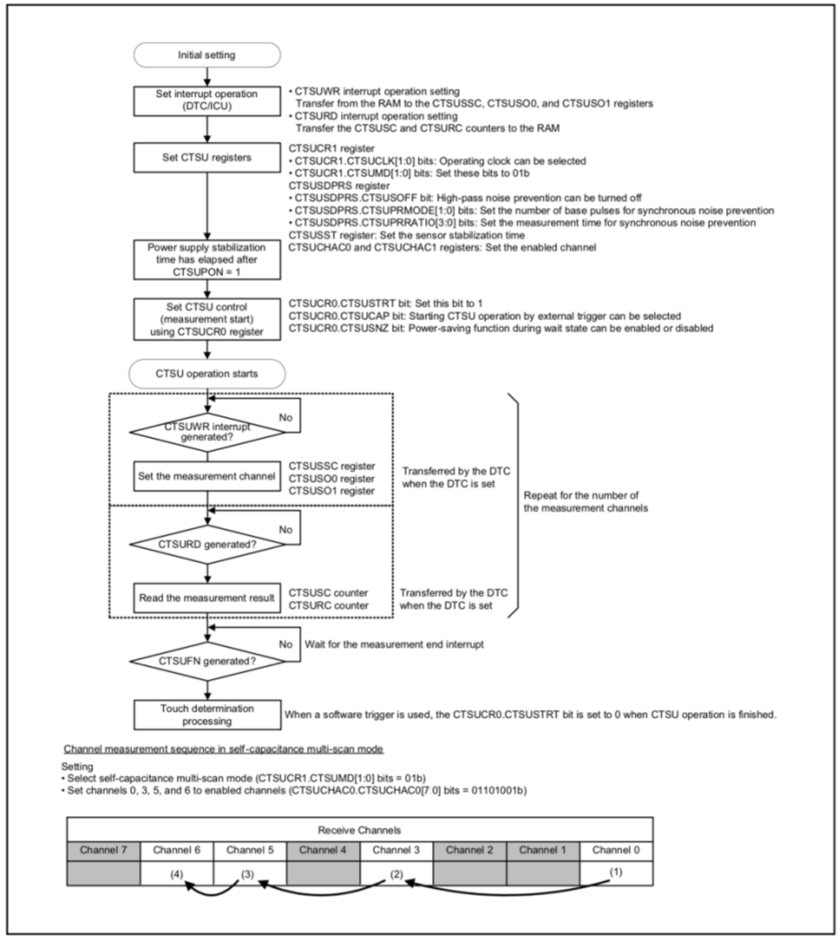
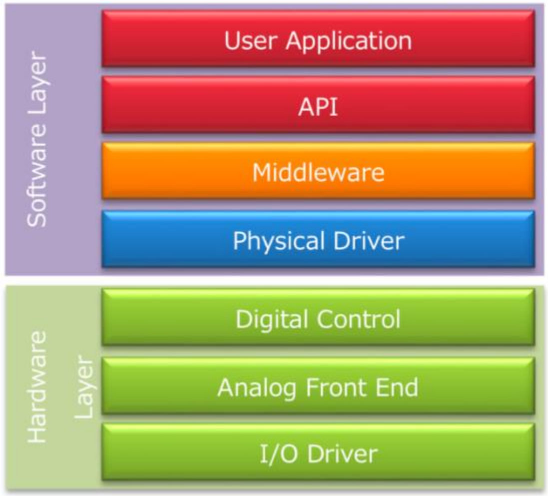
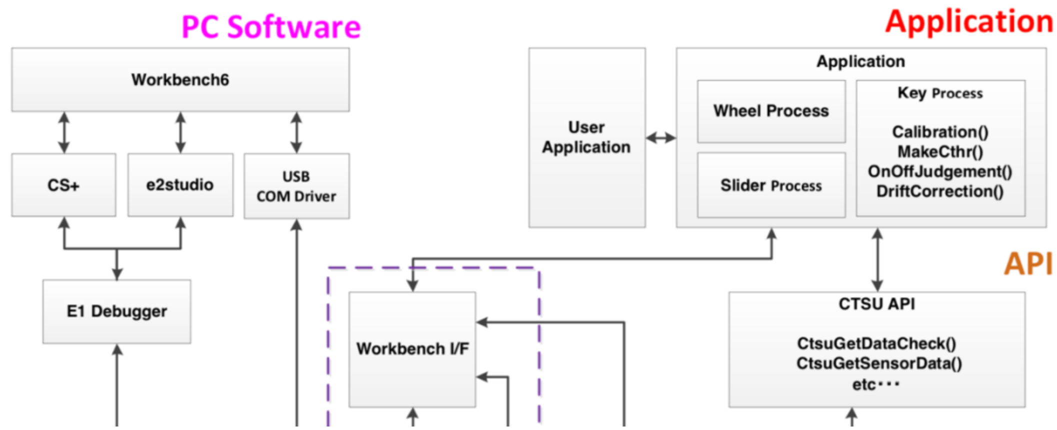



**Figure 35.14 Software Flow and Operation Example of Self-Capacitance Multi-Scan Mode**

*See* https://www.renesas.com/en-us/doc/products/mpumcu/doc/rx_family/r01uh0448ej0110_rx113.pdf at 1221.

| | |
|---|---|
| | **3.1 Overview**<br>Overview of Renesas's capacitive touch detection system is shown in figure 3-1. The system is divided into a hardware part and a software part. The Hardware part includes I/O Driver part that connects directly to touch electrode and convert the capacity to electric current in pulse drive, Analog Front End part that converts the electric current to frequency, and Digital Control part that passes capacity measurement value to software by controlling these blocks. The Software part includes Device Driver that controls hardware, Middleware API that performs position determination of finger by slider, wheel, and matrix electrode, and Middleware API and user application that performs I/F with upper application.<br><br><br>Figure 3-1 Renesas's capacitive touch system<br><br>*See* https://www.renesas.com/en-us/doc/products/mpumcu/apn/rx/002/r30an0218ej0100_rx113.pdf at 8 |

| | |
|---|---|
| | 3.3 Firmware<br>3.3.1 Overview<br>General View of Software is shown in figure 4-10. Software consists of Physical Driver, Middleware, API, and Application. Physical Driver exchanges data directory with CTSU and exchange the data with upper layer. Middleware process the ICO value obtained via Physical Driver and pass it to API. It also has a role to pass the command which is specified by the upper layer to Physical Driver. API mediates the exchange of data between Application layer and Middleware layer. Application is the entity of touch key, slider, and wheel processing. It returns ON/OFF status of the key and the finger position on the slider and wheel depending on the request of User Application. Also, it includes the debugger interface to connect with the capacitive touch integrated development environment "Workbench6" and USB interface.<br><br><br>*See* https://www.renesas.com/en-us/doc/products/mpumcu/apn/rx/002/r30an0218ej0100_rx113.pdf at 14<br><br>3.3.5 Application<br>Application is an entity of touch key, slider, and wheel processing. It performs the following processing from data that was collected by API.<br>-Calibration processing<br>-Follow-up correction processing of measurement data to environmental changes<br>-ON/OFF processing of the key<br>-Detection processing of slider and wheel position<br>-User's applications such as system control of the product and display of LED and LCD. |

| | |
|---|---|
| | *See* https://www.renesas.com/en-us/doc/products/mpumcu/apn/rx/002/r30an0218ej0100_rx113.pdf at 15<br><br><br>*See* https://www.renesas.com/en-us/doc/products/mpumcu/doc/rx_family/r30ca0159ej0300-touchkey.pdf at 1 |

**Hygienic and less prone to malfunction**

Mechanical key assemblies have physical gaps that allow dust and water to get inside. In contrast, touch keypads have a flat surface that can easily be wiped clean with a cloth. Their excellent resistance to dust and moisture make them more durable than mechanical key assemblies, and they are less prone to malfunction when used as frequently operated controls.

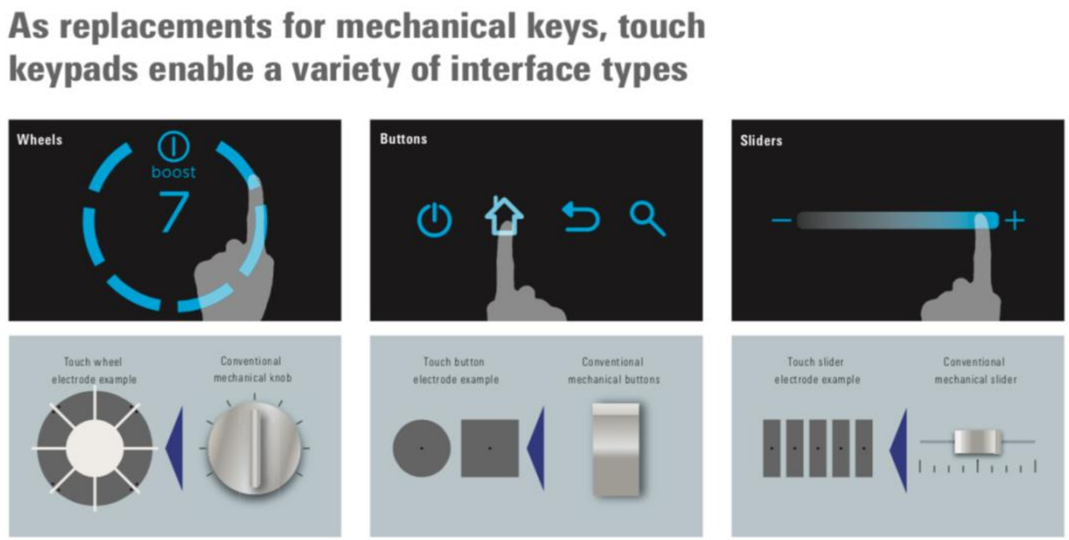
Flat panel with excellent resistance to dust and moisture

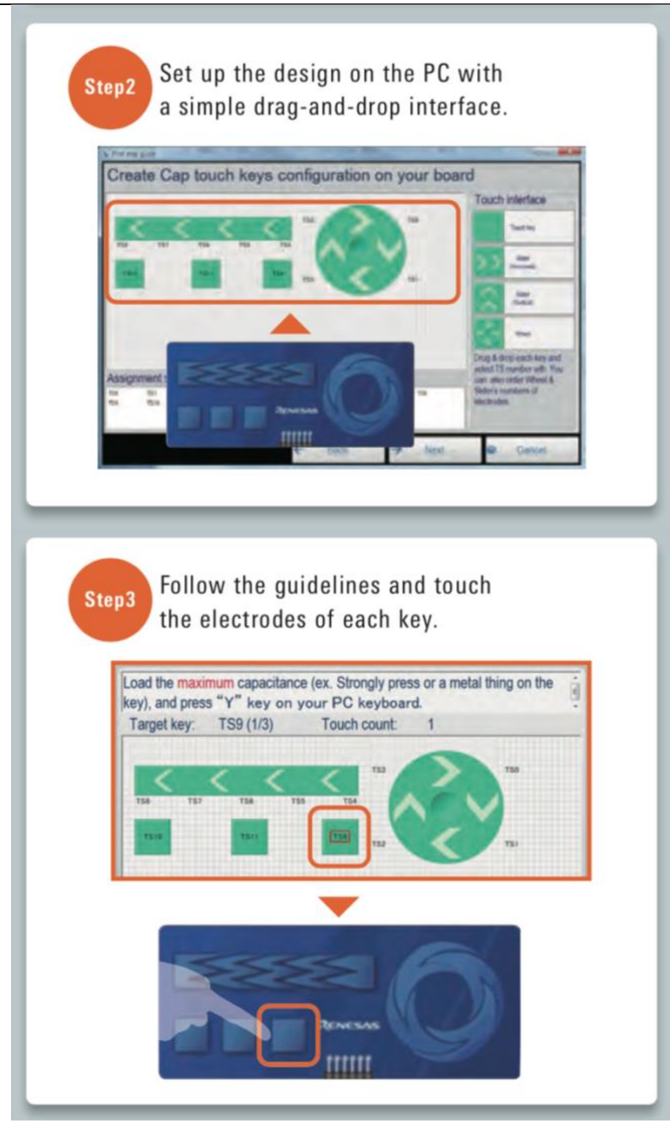

**Attractive design possibilities**

Touch keypads can be configured to blend in visually with the exterior casing of products, providing a great deal of design flexibility. No longer is it necessary when adding new functions to a product to provide complex and diverse mechanical controls such as wheels, buttons and sliders. Capacitive touch interfaces provide an excellent HMI with high added value by combining ease of operation and aesthetically appealing design.

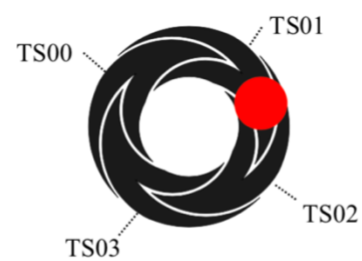
Neat design integration of function keys of different types

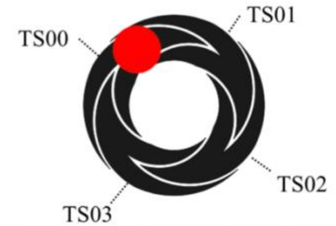
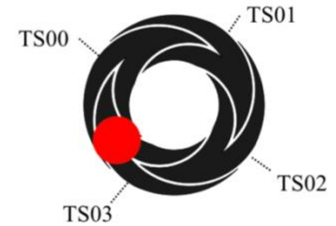
*See* https://www.renesas.com/en-us/doc/products/mpumcu/doc/rx_family/r30ca0159ej0300-touchkey.pdf at 3

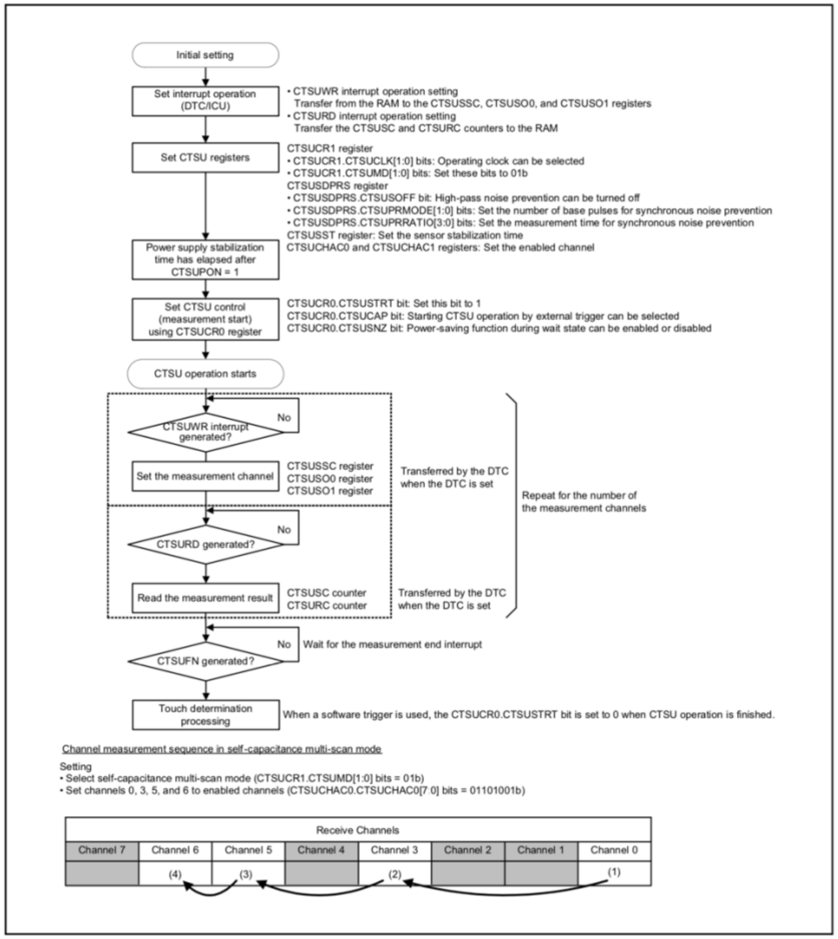
| | |
|---|---|
| | <br><br>*See* https://www.renesas.com/en-us/doc/products/mpumcu/doc/rx_family/r30ca0159ej0300-touchkey.pdf at 3 |

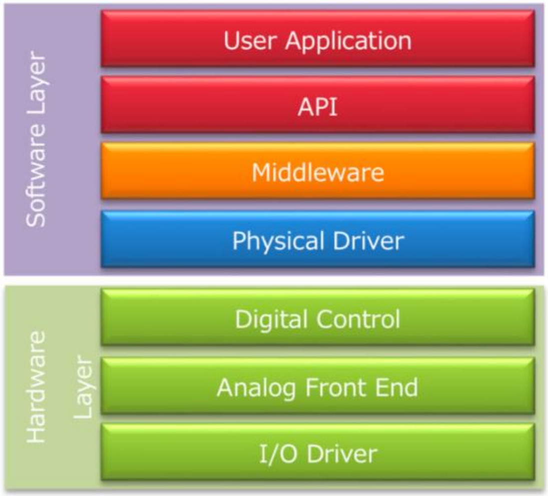


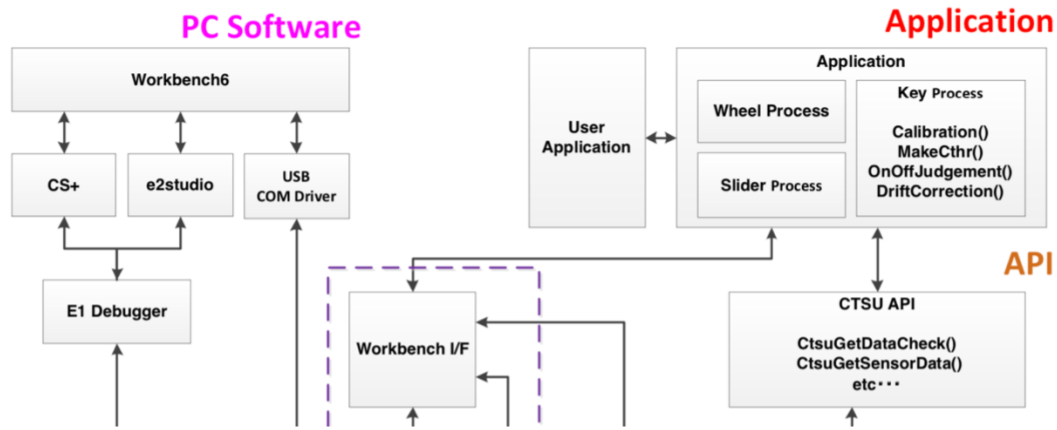

*See* https://www.renesas.com/en-us/doc/products/mpumcu/doc/rx_family/r30ca0159ej0300-touchkey.pdf at 4

| | |
|---|---|
| [1d] receiving one or more second signals indicating one or more second capacitive couplings of the object with the sensing element, the second capacitive couplings corresponding to a displacement of the object along the sensing path from the first position; and | The RX113 MCU receives one or more second signals indicating one or more second capacitive couplings of the object with the sensing element, the second capacitive couplings corresponding to a displacement of the object along the sensing path from the first position. *See, e.g.*, analysis and evidence in claim element 1[a] above.<br><br>For example, the RX113 MCU implements touch and movement functionality where the user places a finger/stylus on the touch sensor and moves it along a path or line. When the user's finger/stylus moves along a path a line ("displacement of the object along the sensing path from the first position"), one or more capacitive couplings between the user's finger/stylus and the touch sensor are formed ("the second capacitive couplings corresponding to a displacement . . ."). Further, the RX113 MCU receives one or more signals indicating the movement ("receiving one or more second signals indicating one or more second capacitive couplings of the object with the sensing element").<br><br>Example : When the touch point is Figure 6.2<br><br><br><br>Non touch measurement data average : 16000<br>g_wheel_data[]<br>[0](TS00) 16500<br>[1](TS01) 17500<br>[2](TS02) 17000<br>[3](TS03) 16000<br><br>**Figure 6.2 Touch point and measurement data**<br><br>The maximum channel becomes TS01 channel from Figure 6.2.<br><br>*See* https://www.renesas.com/en-us/doc/products/mpumcu/apn/rx/002/r30an0216ej0100_rx113.pdf at 61. |

| | |
|---|---|
| | **Pattern 1**<br>maxch[]<br>[0] 1 --- Max measurement data channel number<br>[1] 0 --- Max measurement data channel number – 1<br>[2] 2 --- Max measurement data channel number + 1<br><br>**Pattern 2** Max measurement data channel = 0<br>maxch[]<br>[0] 0 --- Max measurement data channel number<br>[1] **3** --- Max measurement data channel number – 1<br>[2] 1 --- Max measurement data channel number + 1<br><br><br>**Figure 6.4 Pattern2 touch point**<br><br>**Pattern 3** Max measurement data channel = 3<br>maxch[]<br>[0] 3 --- Max measurement data channel number<br>[1] 2 --- Max measurement data channel number – 1<br>[2] **0** --- Max measurement data channel number + 1<br><br><br>**Figure 6.5 Pattern3 touch point**<br><br>*See* https://www.renesas.com/en-us/doc/products/mpumcu/apn/rx/002/r30an0216ej0100_rx113.pdf at 62. |

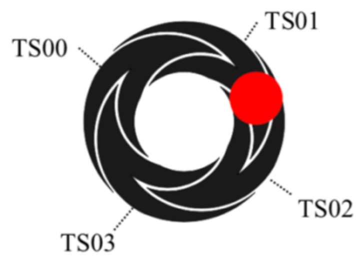
| | |
|---|---|
| | 35.3.2.4 Self-Capacitance Multi-Scan Mode Operation<br><br>In self-capacitance multi-scan mode, electrostatic capacitance on all channels that are specified as measurement targets by setting the CTSUCHAC0 and CTSUCHAC1 registers are measured sequentially in ascending order. Figure 35.14 shows the software flowchart and an operation example, and Figure 35.15 shows the timing chart.<br><br><br><br>**Figure 35.14 Software Flow and Operation Example of Self-Capacitance Multi-Scan Mode**<br><br>*See* https://www.renesas.com/en-us/doc/products/mpumcu/doc/rx_family/r01uh0448ej0110_rx113.pdf at 1221. |

| | |
|---|---|
| | 3.1 Overview<br>Overview of Renesas's capacitive touch detection system is shown in figure 3-1. The system is divided into a hardware part and a software part. The Hardware part includes I/O Driver part that connects directly to touch electrode and convert the capacity to electric current in pulse drive, Analog Front End part that converts the electric current to frequency, and Digital Control part that passes capacity measurement value to software by controlling these blocks. The Software part includes Device Driver that controls hardware, Middleware API that performs position determination of finger by slider, wheel, and matrix electrode, and Middleware API and user application that performs I/F with upper application.<br><br><br>Figure 3-1 Renesas's capacitive touch system<br><br>*See* https://www.renesas.com/en-us/doc/products/mpumcu/apn/rx/002/r30an0218ej0100_rx113.pdf at 8 |

| | |
|---|---|
| | 3.3 Firmware<br>3.3.1 Overview<br>General View of Software is shown in figure 4-10. Software consists of Physical Driver, Middleware, API, and Application. Physical Driver exchanges data directory with CTSU and exchange the data with upper layer. Middleware process the ICO value obtained via Physical Driver and pass it to API. It also has a role to pass the command which is specified by the upper layer to Physical Driver. API mediates the exchange of data between Application layer and Middleware layer. Application is the entity of touch key, slider, and wheel processing. It returns ON/OFF status of the key and the finger position on the slider and wheel depending on the request of User Application. Also, it includes the debugger interface to connect with the capacitive touch integrated development environment "Workbench6" and USB interface.<br><br><br>*See* https://www.renesas.com/en-us/doc/products/mpumcu/apn/rx/002/r30an0218ej0100_rx113.pdf at 14<br><br>3.3.5 Application<br>Application is an entity of touch key, slider, and wheel processing. It performs the following processing from data that was collected by API.<br>-Calibration processing<br>-Follow-up correction processing of measurement data to environmental changes<br>-ON/OFF processing of the key<br>-Detection processing of slider and wheel position<br>-User's applications such as system control of the product and display of LED and LCD. |

| | |
|---|---|
| | *See* https://www.renesas.com/en-us/doc/products/mpumcu/apn/rx/002/r30an0218ej0100_rx113.pdf at 15 |
| [1e] determining based on one or more of the second signals the displacement of the object along the sensing path; and | The RX113 MCU determines based on one or more of the second signals the displacement of the object along the sensing path. *See, e.g.*, analysis and evidence in claim elements 1[a] and 1[b] above.<br><br>For example, as the user's finger/stylus ("object") moves in a line or path on the touch sensor ("the displacement of the object along the sensing path"), the RX113 MCU receives one or more second signals that indicates the movement.<br><br>For example, the RX113 MCU has functionality that tracks touch and movement, including receiving information about the location, size, and movement of a touch occurring on the screen. This also includes information for the view or window in which the touch occurred, the location of the touch within the view or window, and the approximate radius of the touch. This also includes information about indicating when the touch occurred, and information about whether the touch began, moved, or ended. |
| [1f] adjusting the parameter within the range of parameter values based on the displacement of the object along the sensing path. | The RX113 MCU adjusts the parameter within the range of parameter values based on the displacement of the object along the sensing path. *See, e.g.*, analysis and evidence in claim element 1[c] and 1[d] above.<br><br>For example, based on the movement of the user's finger/stylus along the sensing path, the RX113 MCU adjusts the parameter within the range of parameter values.<br><br>For example, the RX113 MCU includes a particular parameter value or setting that can be adjusted, and is associated with a range of parameter values, i.e., the range of adjustment. Further, the range of parameter values or settings is associated with the length of a sensing path and can be adjusted along the length of that path. |

Example : When the touch point is Figure 6.2




Non touch measurement data average : 16000
g_wheel_data[]
[0](TS00) 16500
[1](TS01) 17500
[2](TS02) 17000
[3](TS03) 16000

**Figure 6.2 Touch point and measurement data**

The maximum channel becomes TS01 channel from Figure 6.2.

*See* https://www.renesas.com/en-us/doc/products/mpumcu/apn/rx/002/r30an0216ej0100_rx113.pdf at 61.

**Pattern 1**

maxch[]

[0] 1 --- Max measurement data channel number

[1] 0 --- Max measurement data channel number – 1

[2] 2 --- Max measurement data channel number + 1

**Pattern 2** Max measurement data channel = 0

maxch[]

[0] 0 --- Max measurement data channel number

[1] **3** --- Max measurement data channel number – 1

[2] 1 --- Max measurement data channel number + 1

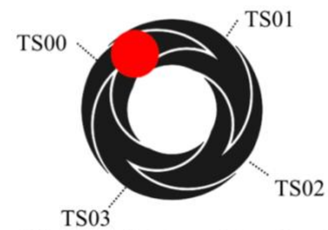



**Figure 6.4 Pattern2 touch point**

**Pattern 3** Max measurement data channel = 3

maxch[]

[0] 3 --- Max measurement data channel number

[1] 2 --- Max measurement data channel number – 1

[2] **0** --- Max measurement data channel number + 1

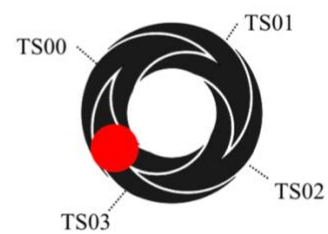
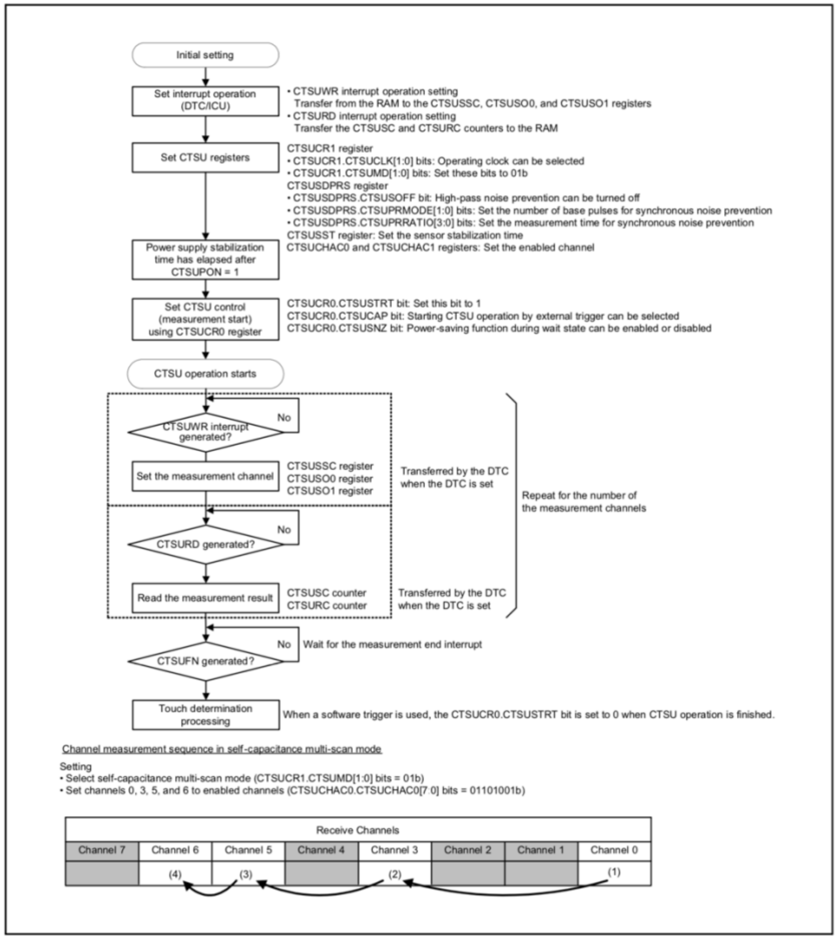
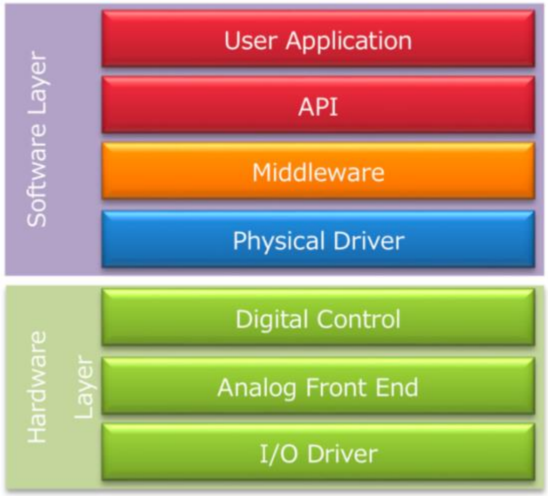
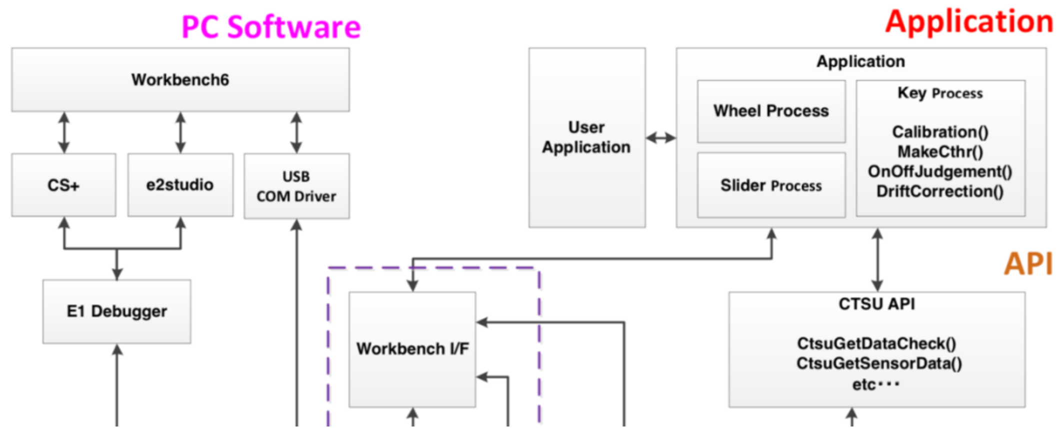



**Figure 6.5 Pattern3 touch point**

*See* https://www.renesas.com/en-us/doc/products/mpumcu/apn/rx/002/r30an0216ej0100_rx113.pdf at 62.

| | |
|---|---|
| | 35.3.2.4 Self-Capacitance Multi-Scan Mode Operation<br><br>In self-capacitance multi-scan mode, electrostatic capacitance on all channels that are specified as measurement targets by setting the CTSUCHAC0 and CTSUCHAC1 registers are measured sequentially in ascending order. Figure 35.14 shows the software flowchart and an operation example, and Figure 35.15 shows the timing chart.<br><br><br><br>Figure 35.14 Software Flow and Operation Example of Self-Capacitance Multi-Scan Mode<br><br>*See* https://www.renesas.com/en-us/doc/products/mpumcu/doc/rx_family/r01uh0448ej0110_rx113.pdf at 1221. |

| | |
|---|---|
| | 3.1 Overview<br>Overview of Renesas's capacitive touch detection system is shown in figure 3-1. The system is divided into a hardware part and a software part. The Hardware part includes I/O Driver part that connects directly to touch electrode and convert the capacity to electric current in pulse drive, Analog Front End part that converts the electric current to frequency, and Digital Control part that passes capacity measurement value to software by controlling these blocks. The Software part includes Device Driver that controls hardware, Middleware API that performs position determination of finger by slider, wheel, and matrix electrode, and Middleware API and user application that performs I/F with upper application.<br><br><br>Figure 3-1 Renesas's capacitive touch system<br>*See* https://www.renesas.com/en-us/doc/products/mpumcu/apn/rx/002/r30an0218ej0100_rx113.pdf at 8 |

| | |
|---|---|
| | 3.3 Firmware<br>3.3.1 Overview<br>General View of Software is shown in figure 4-10. Software consists of Physical Driver, Middleware, API, and Application. Physical Driver exchanges data directory with CTSU and exchange the data with upper layer. Middleware process the ICO value obtained via Physical Driver and pass it to API. It also has a role to pass the command which is specified by the upper layer to Physical Driver. API mediates the exchange of data between Application layer and Middleware layer. Application is the entity of touch key, slider, and wheel processing. It returns ON/OFF status of the key and the finger position on the slider and wheel depending on the request of User Application. Also, it includes the debugger interface to connect with the capacitive touch integrated development environment "Workbench6" and USB interface.<br><br><br>*See* https://www.renesas.com/en-us/doc/products/mpumcu/apn/rx/002/r30an0218ej0100_rx113.pdf at 14<br><br>3.3.5 Application<br>Application is an entity of touch key, slider, and wheel processing. It performs the following processing from data that was collected by API.<br>-Calibration processing<br>-Follow-up correction processing of measurement data to environmental changes<br>-ON/OFF processing of the key<br>-Detection processing of slider and wheel position<br>-User's applications such as system control of the product and display of LED and LCD. |

| | |
|---|---|
| | *See* https://www.renesas.com/en-us/doc/products/mpumcu/apn/rx/002/r30an0218ej0100_rx113.pdf at 15 |